

# **Brief Overview of Non-Power Applications of Radiation**

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# Uses of Radiation to Serve Humanity

- **Power Applications**
  - Electricity, H<sub>2</sub> Production, Potable Water
- **Non-Power Applications**
  - Medicine
  - Agriculture
  - Industry
  - Environmental Protection
  - Public Safety & Basic Science
  - Space Exploration

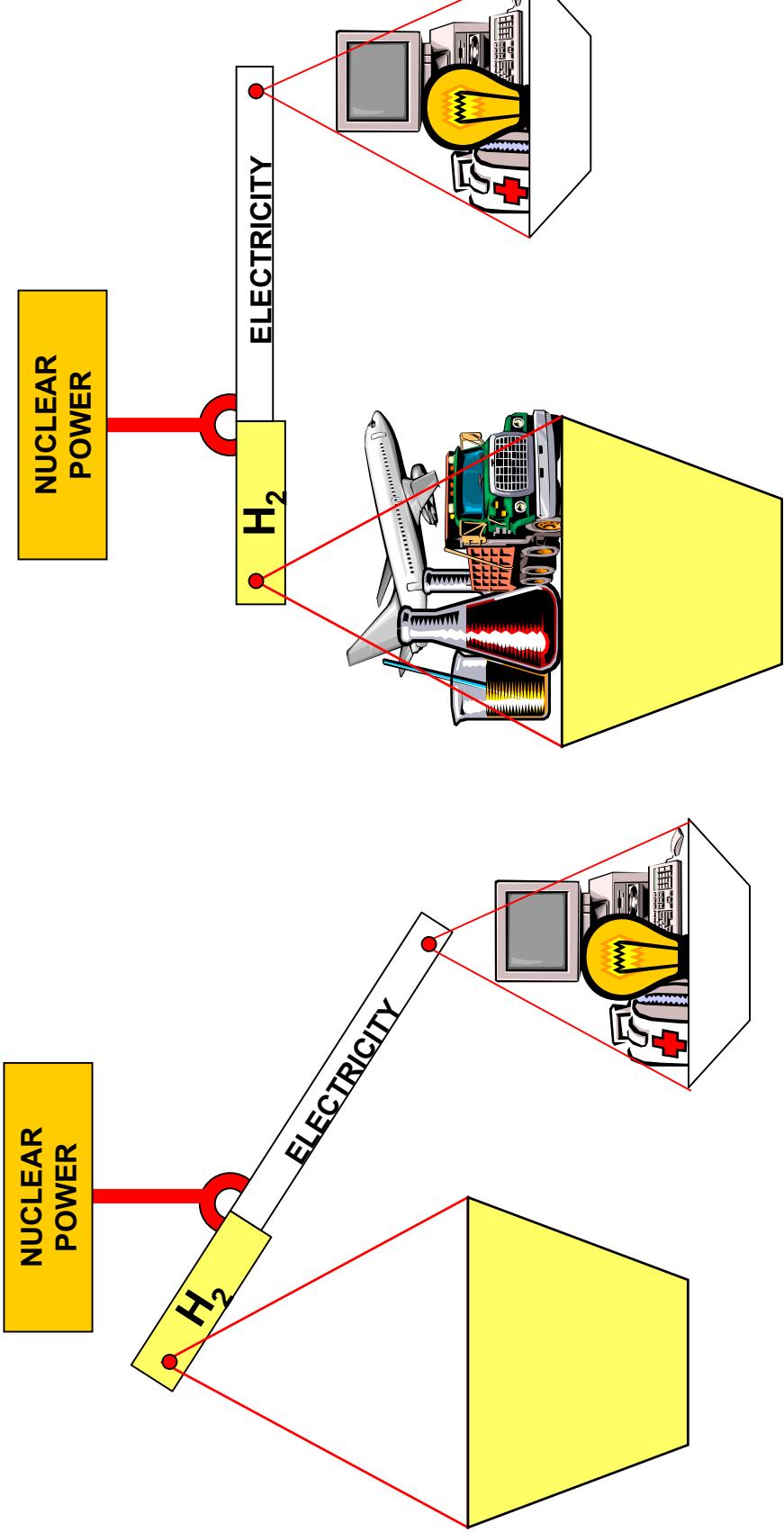
# **HYDRICITY\***

## The Hydrogen-Electricity Era

- Fuel Cells Likely Necessary for Transportation Sector
- Hydrogen Required as Fuel
- Nuclear Reactors have Enormous Potential for Producing Hydrogen
- Nuclear Power Market for Hydrogen Production Likely *Larger* than for Electricity Production!
  - By electrolysis or high temperature thermo-chemical processes emitting no CO<sub>2</sub>
  - Huge challenge for next-generation nuclear engineers

# Nuclear Power Services

## Today and Tomorrow



# MEDICINE

- 12 Million patients per year
  - 1 in 3 patients in U.S. hospitals

- **Sterilization of Medical Products**
  - Surgical dressings, sutures, catheters, syringes

- **New Drug Testing**
  - Over 80% of all new drugs tested with radioactive tagging before approval

- **Diagnosis**

- Technetium-99 extensively used for bone cancer, prostate cancer
- Imaging for heart, brain, lung disorders
- Imaging for cancer tumors
- Radioimmunoassay (determine levels of hormones, vitamins, enzymes, drugs)

- **Therapy**

- Decrease pain of bone cancer
- Hyperthyroidism (20,000 patients/year)
- Cancer (direct gamma, “smart bullets”)

# AGRICULTURE

- Reduce Needs for Fertilizers and Water
- Speed Breeding of Improved Crops
  - Greater yield
  - Increased disease resistance
  - Better nutritional value
- Animal Husbandry
  - Increase body weight
  - Vaccines to eliminate diseases
- Insect Control
  - Sterilization (screw worm, Mediterranean fruit flies, gypsy moths)
- Food Irradiation
  - Kill bacteria, molds, yeasts, parasites, insects
  - Extend shelf life

# INDUSTRY

- **Tracers** (pipeline leaks, malfunctions, wear and corrosion)
- **Thickness Gauges** (sheet metal, paper, textiles)
- **Density Gauges** (oil and food industries)
- **Inspection** (welds in airplanes, oil and gas pipelines)
- **Smoke Detectors** (unmatched reliability)
- **Lighting** (airports, exit signs, traffic control)
- **Tires** (vulcanize rubber)
- **Reduce Static Electricity** (printing process, paper making)

# Environmental Protection

## .....ENVIRONMENTAL POLLUTION.....

- Determine 1) Amounts and Locations of Pollution
- 2) Causes of Pollution
- 3) Proper Remedy

## • Air Pollution & Global Climate Change

- Uptake of greenhouse gasses by plants and the sea
- Measure CO<sub>2</sub> release by individual plants

## • Water Pollution

- Measure CO<sub>2</sub> levels in sea water (microscopic phytoplankton aggregation)
- Tracer technique for salt water/fresh water mixing; cause of pollution

## • Soil Pollution

- Identify pesticide & fertilizer decomposition product locations
- Identify source of contamination

# **Public Safety & Basic Science**

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- **Fighting Terrorism**
  - Luggage Inspections (metals, nitrides, etc.)
  - Anthrax in Mail
  - Sensing Clandestine Weapons Testing
  - Sensing Contamination Releases
- **Safety & Science**
  - Airport Runway Lighting
  - Dating Techniques (archeology, etc.)

# Space Exploration

- **Electrical Generation**
  - Radio-Thermal Generators (RTG)
    - Pu-238 excellent heat source (87.7 yr half-life)
    - Direct conversion to electricity (~ 7% efficiency)
  - Dynamic Isotope Power System (DIPS)
    - Pu-238 still excellent heat source
    - Rankine cycle active system (~20% efficiency)
- **Nuclear Reactors**
  - For Missions > 100 kW

# Ubiquity of Radiation Applications

Overall Impact in the U.S.  
(1995 Data, Based on Multiplicative Effects)

	SALES \$ Billions	JOBS Millions
Radioisotopes	331	4.0
Nuclear Energy	<u>90</u>	<u>0.4</u>
	<b>421*</b>	<b>4.4</b>

- \*Larger than General Motors
- \*Larger than entire U.S. Airline Industry

# Japanese Study for 1997

(Direct Financial Contributions)

	<u>Japan</u>	<u>USA</u>	
Population (M)	120	270	
GDP (\$B)	4231	8318	
<b>RADIOISOTOPES</b>	Medicine Agriculture Industry	12 1 <u>39</u> <u>52</u>	49 14 <u>56</u> <u>119</u>
<b>NUCLEAR ENERGY*</b>		<u>47</u>	<u>39</u>
<b>TOTAL =</b>		<b>99</b>	<b>158</b>
%GDP =		(2.3)	(1.9)

\* kW-hr price assumed: Japan = 15.0 cents; USA = 6.8 cents

# Japanese/USA Comparison for 1997

## Using Multiplicative Effect of 2.3

	SALES \$ Billions	
<u>JAPAN</u>	120	<u>USA</u>
Radioisotopes	274*	228
Nuclear Energy	108	364
	90	(5.3)
		(4.4)

\* Does not include several industrial applications